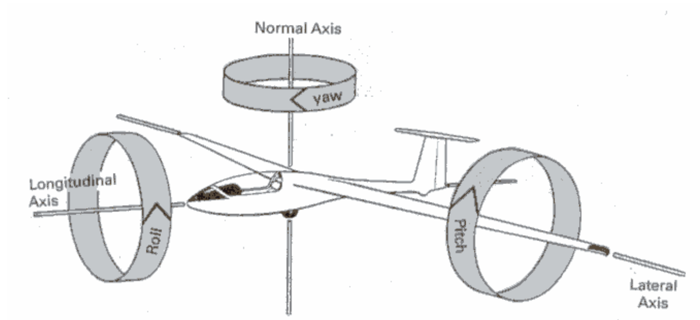
EFFECTS OF CONTROLS (PRIMARY)

Aim: To learn the primary effects of the flight controls.

Wow…our first practical, hands on, go at flying…YIPPEE. Flying is easy and fun so we shall aim to get you controlling the glider after a brief introduction to the flight controls used to fly the glider. Let's take a look at how we do it…how we fly it.

Our glider is equipped with flight controls that we as pilots use to manoeuvre and control the glider both on the ground and in the air. The glider can be controlled in 3 dimensions with movements about 3 defined axis as shown here.

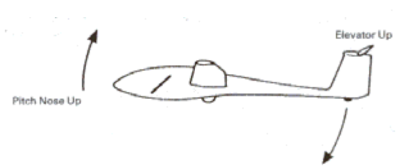


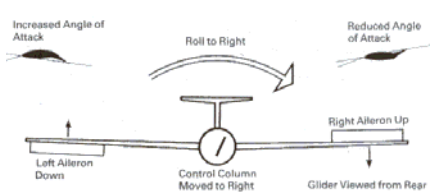
Note that each axis sits at 90° to the other 2 and all pass through the glider's Centre of Gravity (C of G).

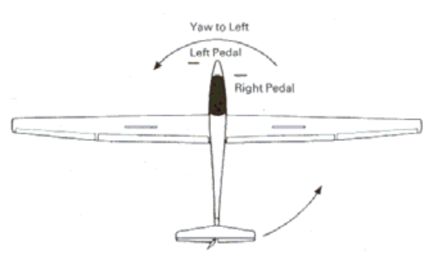
Flight Controls:
The 3 main flight controls; the Elevator, the Ailerons and the Rudder, are those used to manoeuvre and control the glider about the 3 axis as follows:

Control	Movement	Axis	Effect
Elevator CC forward / aft	Pitch Nose down / up	Lateral	pitches to a lower nose attitude, glider speeds up pitches to a higher nose attitude, glider slows down
Aileron CC left / right	Roll Bank left / right	Longitudinal	glider rolls into a banked attitude & turns left glider rolls into a banked attitude & turns left
Rudder Pedals left / right	Yaw Nose left / right	Vertical	glider yaws left and skids along sideways glider yaws right and skids along sideways

How the Controls Work:
Each control surface enables a variation in the camber of the airfoil which generates aerodynamic force over the area of the control in a particular direction. This change in the balance of forces generates the response about a particular axis as shown in the diagrams below.







Elevator **Aileron** **Rudder**

Control Feel, Responsiveness and Effectiveness:

We see from the table above the effect of each control as it is applied but there are a few other things to consider when talking *control feel, responsiveness* and *control effectiveness,* all terms used when describing handling and control of gliders. All three are influenced by the speed of the airflow over the gliders control surfaces, the rate of application and the amount of control input applied.

At low speed, the controls
- feel lighter and easier to apply inputs
- are less responsive to our input
- are less effective for the same amount of input

At higher speed, the controls
- feel heavier and require more force to apply inputs
- are more responsive to our input
- are more effective for the same amount of input

Applying the control at a slow rate
- we get a slow response

Applying the control at a quick rate
- we get a quick response

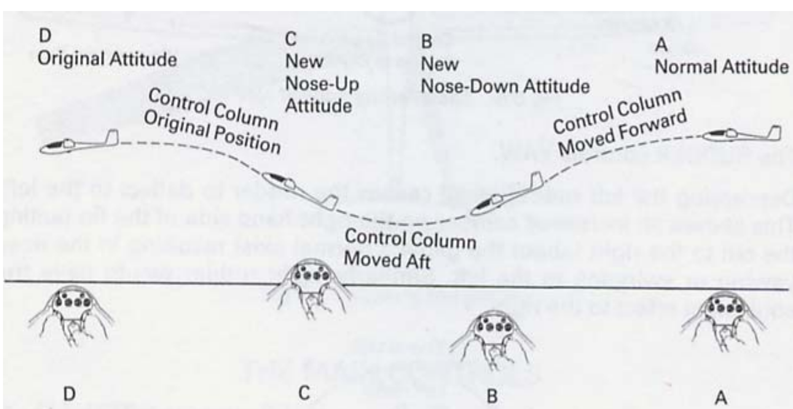
Applying a small amount of control input
- we get a small / slower response

Applying a large amount of control input
- we get a large / quicker response

The most effective control is the elevator; gliders are relatively sensitive in pitch. The ailerons make rolling the next most sensitive control and the rudder is considered the least sensitive control of the three primary controls. The manufacturers design the controls this way to give the best control feel and harmonization for the pilot.

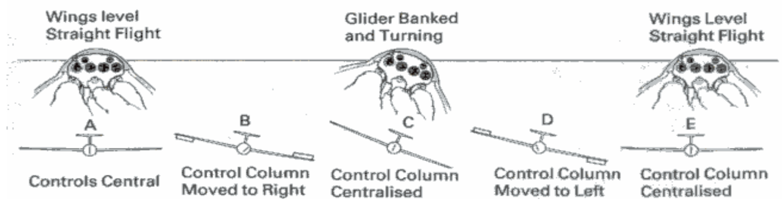
Air Exercise:
Your instructor will complete the launch and establish the glider in a steady glide at 45 knots. They will show you that the glider can fly itself in a steady glide and that we as pilots only apply a control input when we want to manoeuvre or to correct any displacement from an outside cause like turbulence. They will point out the *normal gliding attitude* for this speed by making reference to the position of the glider's nose in relation to the horizon ahead. You will be asked to *follow through* on the controls so when inputs are made, you can feel the rate and amount of control input and see the effect and response of the input.

The first demo will be controlling pitch using the elevator to vary our pitch attitude. Easing the control column forward pitches the nose down to a lower nose attitude. The glider accelerates and the noise changes as the speed increases. Note that only small inputs are required to pitch to a new attitude and once held, the glider stabilizes at this new attitude at a higher speed. Easing the control column back pitches the nose up; the glider decelerates, the noise reduces and we settle at a new attitude, a high nose attitude relative to our original normal gliding attitude.

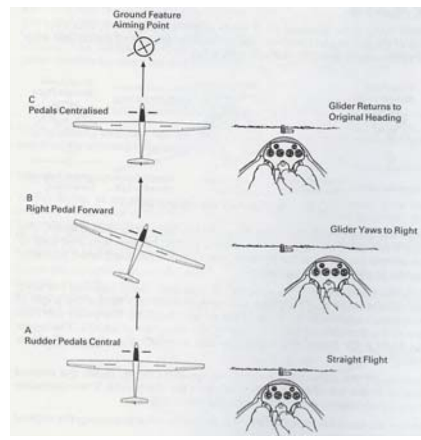


The next demo is rolling the glider using the ailerons to give us a *banked attitude*. We move the control column to the left and the glider rolls to the left; we see the left wing go down and the right wing go up to give us a banked

attitude to the left. Note that the glider will continue to roll whenever aileron is applied so to maintain a particular banked attitude, we need to return the control column to the centre. Note the angle of the horizon to the nose of the glider; it is no longer symmetrical. When the glider is banked, it turns in that direction.
Applying aileron by moving the control column to the right rolls the glider back towards the wings level normal gliding attitude. Again, we centralize the control column when we get the wings level and the glider flies straight.



Now lets see what the rudder does. We pick a point ahead on the horizon as a reference so we can see what happens. Follow through as left rudder is applied by moving the left pedal forward (allowing the right pedal to come back towards us) and see the nose of the glider yaws or swings to the left.
The glider then skids along slightly sideways while still flying towards our point. Centralising the rudder sees us yaw back to the right till we are again pointing at our reference point ahead on the horizon.



Rudder doesn't turn the glider in flight… so what does it do? We will see in following exercises that it is used to assist the primary turning control, the aileron, by coordinating its application to ensure we maintain balanced flight as we roll to a banked attitude. That mouthful will become clearer…trust me!

You will be given control of each control and asked to try some control inputs. Make control inputs smoothly and deliberately and look for the effect and response.

Horizon and Attitude
We use the horizon as a convenient reference to see the response to control inputs but it is important to understand that the controls work relative to the glider and us in it. This is best understood by thinking of the movements when the glider is banked say at 90°… pulling back on the control column pitches the nose up relative to us inside the glider… but does not move the nose up relative to the external horizon… it appears to move across the horizon. Go further to have the glider upside down…pulling back pitches the nose up relative to us inside the glider but will take it below the external horizon! But hey… we aren't into aerobatics yet… but do remember that the controls work relative to **us** and that the horizon is only a convenient reference when talking attitudes.

Other Controls:
The other controls includes things like the Trim, Airbrakes, Flaps, Undercarriage etc which all effect the gliders handling and performance will be dealt with in separate exercises.

Tips:
This is our first lesson on controlling the glider. There is quite a bit to see and take in. We will often refer back to this very basic exercise as we learn more about how to fly the glider. This is the crux of being the pilot in control and ultimately in command of the glider, determining how it is flown safely, efficiently and effectively.

We will be handing over / taking over control a fair bit…ensure you know how to do this to avoid any confusion so you can concentrate on the exercise.

During the launch and after the main lesson, take time to relax and practise your lookout and orientation. Take in the sights; ask questions… enjoy being airborne while most others are left earthbound!!…have fun.

Need To Know:

- How a control works.
- The effect of any control input.
- The terminologies and jargon used when talking about effect of control.

Further Reading:

- The Glider Pilot's Manual; by Ken Stewart. Pg 36. All about the effects of controls.

EFFECTS OF CONTROLS (SECONDARY)

Aim: To learn about any secondary effects of flight control inputs.

We have seen the primary effect of controls… now lets explore any secondary effects… that is… does anything else happen when we pitch, roll or yaw… does one movement have more than the single effect we have seen so far?

Secondary Effects:
A secondary effect of control can be defined as any effect about one of the 3 main axis of motion which occurs as a result of an initial control input.

If we pitch the glider, will it roll or yaw? No… so there is no secondary effect of pitch.

How about if we apply aileron and roll the glider… it banks, slips towards the lower wing then yaws towards that lower wing… so yes, there is a secondary effect of roll and it is yaw.

And yawing…we apply some rudder…the glider yaws, skids sideways and rolls towards the direction of the yaw.

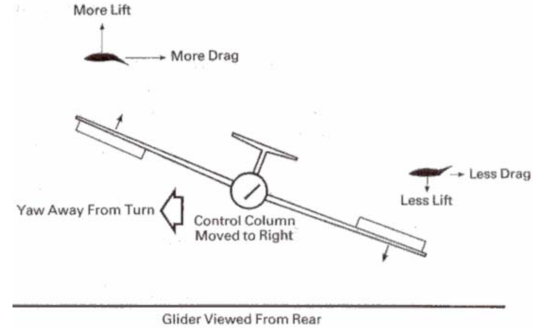
Your instructor will set the glider up in a normal gliding attitude at 45kts and demonstrate these secondary effects so you can see them. To summarise then:

Control	Axis	Primary Effect	Secondary Effect
Elevator	Lateral	Glider pitches nose up and down	there is no roll or yaw
Aileron	Longitudinal	glider rolls left / right	the glider slips towards the lower wing, then yaws towards the lower wing
Rudder	Vertical	glider yaws left glider yaws right	The glider skids then rolls towards the inner wing

So What?!
Applying elevator to pitch the nose up or down has no secondary effect to consider. But when we roll the glider to bank it to get it to turn, we get a secondary effect… slip. which is undesirable as it means the glider is no longer aligned with the relative airflow. This momentarily increases our drag and reduces our glide angle. To avoid this, we need to apply a little rudder in the same direction as the aileron to yaw the glider into the relative airflow rather than allow it to slip first.
How about the yaw leading to roll… how is this important? Well, it isn't in the air when flying normally but is useful if we lose roll effectiveness… when at or near the stall or when on the ground at slow speed. Applying rudder can yaw the glider and then cause it to roll sufficiently to pick a wing up or at least stop a wing dropping further. More on this in later exercises though.

But…there is something even more significant that happens when we roll a glider and we need to look at this.

Adverse Yaw Caused by Aileron Drag

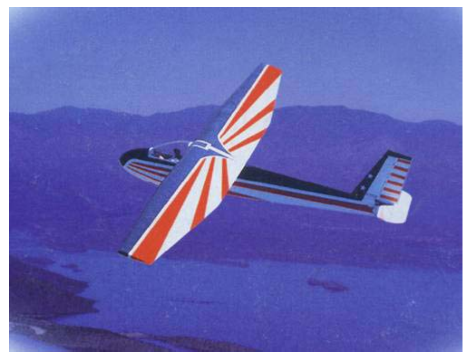


The design of the glider with its long wings with ailerons out near the tips gives rise to this significant handling effect. When aileron is applied, the down going one increases its camber and angle of attack to the relative airflow, thereby generating lift to lift the wingtip and roll the glider while at the other wingtip the upgoing aileron is reducing camber and angle of attack, reducing the local lift and allowing roll towards it. As more lift is generated by the downgoing aileron, more drag accompanies it, while the opposite is happening on the upgoing aileron. This extra drag is called *Aileron Drag*. The difference in drag at the tips generates yaw…*adverse yaw,* away from the desired direction of turn.

Air Exercise:
Your instructor will demonstrate this adverse yaw by setting the glider up in a wings level glide at 45 kts heading towards a prominent feature on the horizon. Holding the rudder neutral, they will apply a large amount of aileron to roll to the left. Look for the nose yawing to the right.
We see that if this occurs whenever we try to roll to bank the glider for a turn, we need to counter this. Applying rudder in the same direction as we apply aileron does the trick… left aileron, left rudder applied smoothly in a coordinated manner stops the adverse yaw. Right aileron and right rudder applied smoothly at the same time stops adverse yaw when we wish to roll and turn to the right.
Having demonstrated with you following through to feel the timing and amount of the control inputs to achieve smooth, balanced flight free of any slip or skid, it is your turn to try the coordinated application of aileron and rudder.

Airmanship:
Its time to introduce the term *airmanship* as an integral part of our flying training. It is used to describe a variety of considerations and actions pilots take to ensure they are safe in what they are doing. When busy learning, watching demonstrations, listening to the Instructor's words, taking control and concentrating on trying to do things as we have been shown, we can forget about some other responsibilities we have as pilots… the things that keep us safe. Airmanship considerations includes things like:

- Keeping an effective lookout and not running into anyone else
- Keeping orientated, knowing where the airfield is at all times
- Staying within safe gliding distance of a place to land
- Thinking ahead… staying ahead of the glider with respect to making decisions
- Being aware of the prevailing weather conditions
- Doing checks out loud and correctly
- Knowing and practicing the correct handover / take over of control



We can be the world's best at control of our glider but if our airmanship skills are poor… we are unacceptably dangerous to ourselves and others.

From now on, we shall include a few airmanship tasks and skills with each exercise so we consciously get to practise them as we go about our learning exercises. Your instructor will gradually and progressively hand over more responsibility for performing appropriate airmanship tasks during each flight.

Tips:
Adverse yaw is significant in gliders and sets them apart from shorter wing powered aircraft where pilots can virtually forget about using the rudder when turning! Mastering this coordinated application of aileron and rudder is not hard… it just takes practice.
As you gain more experience, it will become instinctive and automatic.

Need To Know:

- How to counter adverse yaw when applying aileron.
- How to walk and chew gum….. just kidding!… that's harder than flying!!

Further Reading:

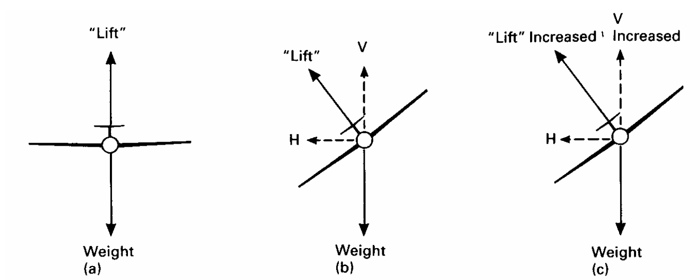
- The Glider Pilot's Manual; by Ken Stewart. Pg 36. All about effects of controls.

TURNS USING UP TO 30° ANGLE OF BANK

Aim: To learn how to change the direction of flight of the glider by turning.

There are numerous reasons for doing turns; from manoeuvering to change direction such as is required to follow the towplane or fly a circuit about our airfield, to thermalling in circling flight to take advantage of rising air… soaring. The ability to accurately turn a glider is a fundamental skill based on our understanding and application of the primary flight controls.

Principals of Turning Flight:
Lets look at the forces acting on a glider in a steady glide. Flying straight, wings level, the forces are in equilibrium. Applying control inputs to bank the glider produces the necessary force from the wing when it is banked. The lift force is tilted and the force vector can be divided into vertical and horizontal components. The horizontal force is is called the *centripetal force* and this is what turns the glider. The vertical component is left to balance the weight and must be increased to achieved this. This is achieved by increasing the tilted lift vector… this is done by increasing our angle of attack by easing back on the control column. This in turn increases the turning force even more. However, if we were not to apply the *back pressure* on the control column, the nose would pitch forward slightly and allow the glider to accelerate above the speed we are trying to maintain. Take a look at the diagram of the forces below:



(a) The vertical force of weight is normally balanced by the resultant of lift and drag.
(b) Banking the glider tilts the resultant and causes the glider to turn.
(c) In turns, it is necessary to increase the angle of attack to restore the vertical component to counter the glider's weight

That's the theory…now the real flying stuff…how we do it!

Air Exercise:
Your instructor will establish the glider in a steady glide at 45 knots. They will then demonstrate a turn, pointing out the sequence of actions and control inputs required to enter the turn, sustain the turn, then exit from the turn. Note the rate and amount of control inputs and the attitude selected once in the turn. Here is the sequence of events:

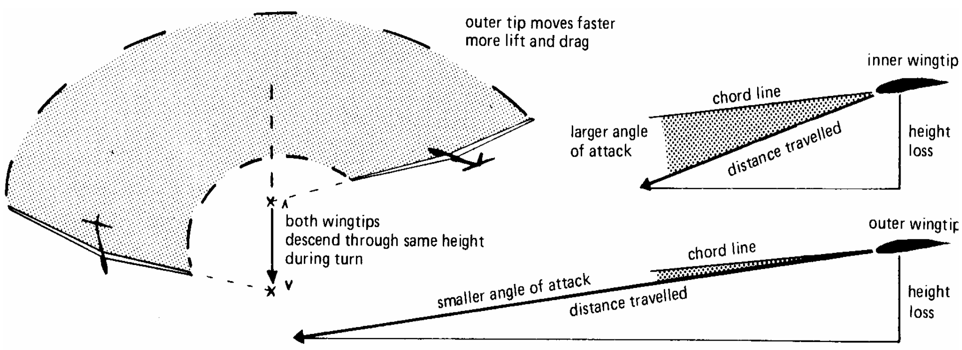
Entry:
- LOOKOUT ahead and in the direction you are going to turn to check it is clear
- Apply aileron and rudder together to roll the glider to the banked attitude in the direction you wish to turn
- Apply a small amount of back pressure on the control column to hold the desired nose attitude
- Centralize the aileron and rudder when you have the desired banked attitude

Sustaining:
- Maintain a lookout in the area ahead you are turning into
- Keep the bank angle constant using small adjustments as necessary
- Maintain the nose attitude with small adjustments to the back pressure as required

Exit:
- LOOKOUT to ensure the are we are rolling out to fly straight through is clear
- Anticipate the direction we wish to roll out and fly to
- Apply aileron and rudder together to reduce the bank and get to a wings level attitude
- Relax the back pressure to achieve the desired pitch attitude for the normal gliding attitude

You will be given control when in a turn so you can feel the small amount of back pressure required to hold the desired nose attitude. You may notice that despite what was just said… the ailerons are not actually centred when in the turn…they are held a little out of the turn… if turning left, we have a little right aileron applied. Why is this so?… any ideas?

Take a look at this diagram which shows how the outer wing is going further and therefore faster in the turn… thereby generating more lift which tries to roll and increase the bank. Applying a little aileron away from the direction of turn hold the bank constant.



The influence of a large span and small turning circle on the handling of a glider. The outer wingtip travels further and faster but meets the airflow at a smaller angle. This results in extra lift and makes a glider tend to over-bank in turns. The inner wingtip will reach the stalling angle before the outer one, causing it to stall and drop if the glider is flown too slowly.

The Yaw String:

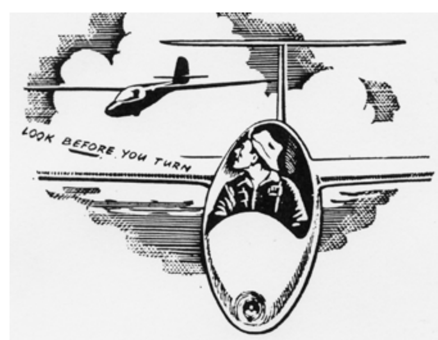
The yaw string can be used to check for slip or skid…our *balance.* If the string is straight, we are flying in balance and the airflow is coming over the glider from directly in front of us. If the string is out to one side, we are out of balance and this will create extra drag on the glider and increase our rate of descent… and mean we land sooner! We can use the string to help correct this situation. Imagine it to be an arrow, with the pointed head at the front of the string where it is taped on to the canopy. Using it as an arrow, it points to the rudder you need to apply to correct the slip or skid to get back into balanced flight.

Common Faults:

Inadequate lookout; this is dangerous and you must really lookout before and during the turn
Not looking out over the nose; this means you won't see any change in attitude so the speed changes
Too much or too little rudder; use the string to correct this and don't chase it or over control
Failing to reduce the rudder once established in the turn; do this when you *centralise* the ailerons
Lack of positive control; remember … you are the pilot so be decisive and positive in control
Jerky control; keep it smoooooth
Allowing the nose to drop; remember you need a little *back pressure* to hold the desired nose attitude
Varying the bank; again…set what you want and don't let it increase or change with turbulence etc
Tensing up on the controls; relax, wiggle your fingers every so often to check you aren't strangling the stick!
Chasing the ASI; forget the ASI…its only a reference and suffers a lot of *lag,* hold an attitude.

Airmanship:

We can't overstate the importance of a good lookout…its more important than the accuracy of your flying. Your instructor will want to see your head moving around in the directions you are looking and may prompt you about lookout if they don't see this.



Need To Know:

- The basic aerodynamics and forces on the glider in a turn.
- The control inputs required for a balanced / coordinated turn.

Further Reading:

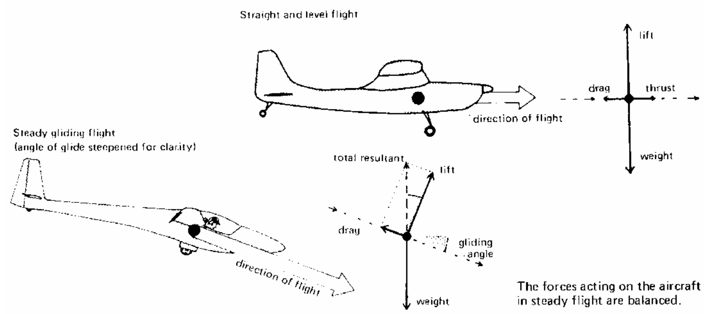
- The Glider Pilot's Manual; by Ken Stewart. Pg 43. Turning.

STRAIGHT GLIDE

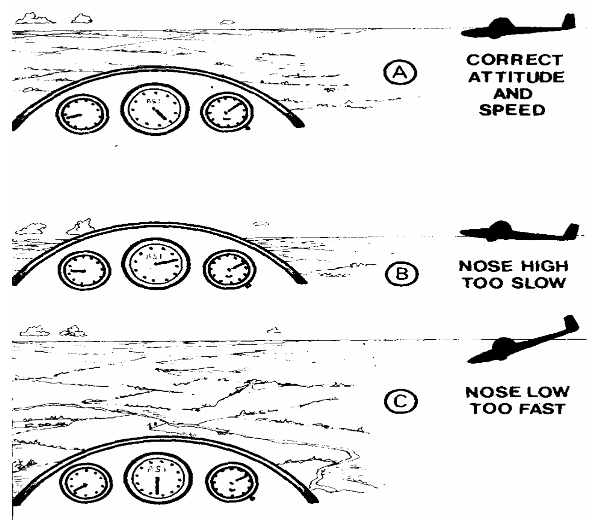
Aim: To learn how maintain a straight glide at a constant speed and in balance.

This exercise develops the basic skills required to achieve flight in a straight line (on a constant heading) at a steady speed. We need to be able to do this as we often have the need to fly in this configuration. This basic exercise is the foundation of several phases of flight including takeoff, gliding between lift sources, flying the circuit, approach and landing.

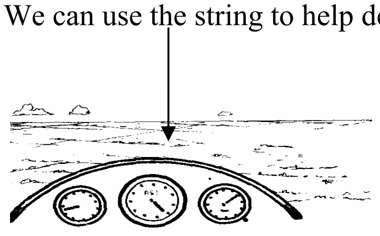
Flying Straight:
To fly straight, we pick a reference point or feature out ahead of us on the horizon. Then, keeping the wings level, we should fly straight towards it. If a wing drops slightly, the glider will turn towards the lower wing so this can be detected by looking out ahead at our reference point on the horizon.

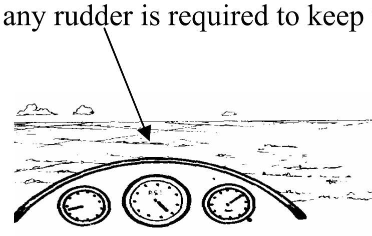


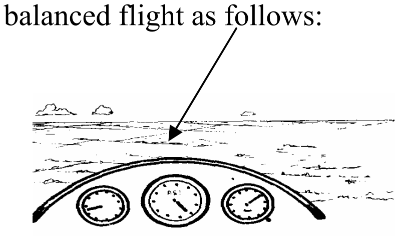
Flying at a Constant Speed:
We want to keep the speed constant, without chasing the reading on the ASI. This is done by maintaining a *constant nose attitude* or pitch attitude. If the nose is too high, the speed reduces, the glider sounds quieter and controls feel lighter.
Conversly, if the nose is too low, we accelerate and the glider sounds a little noisier for the increase in airflow and the controls are a little heavier and more sensitive.
We need to reselect the nose attitude to where we think it should be for the speed we want, hold it there and retrim…which we will cover in another lesson!!… and then check the ASI to see what speed we have.
Make small, deliberate corrections to the nose pitch attitude.



Flying in Balance:
We can use the string to help decide if any rudder is required to keep us in balanced flight as follows:


We are in balance


We need a little right rudder to straighten the string


We need a little left rudder to straighten the string

Incidentally, we often hear this exercise called *straight and level*. This term is really a hangover from flying powered aircraft and strictly speaking is not achievable in a glider as we are constantly descending through the air we are in.

Need To Know:
- How to achieve and maintain a straight glide at a constant speed and in balance.
- How to return to this glide if displaced from it.

Further Reading:
- The Glider Pilots Manual. by Ken Stewart. Steady glides.

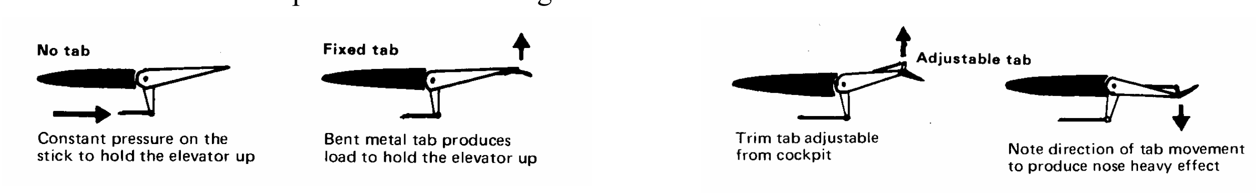
USE OF TRIM

Aim: To learn the function and use of the trim system fitted to the glider.

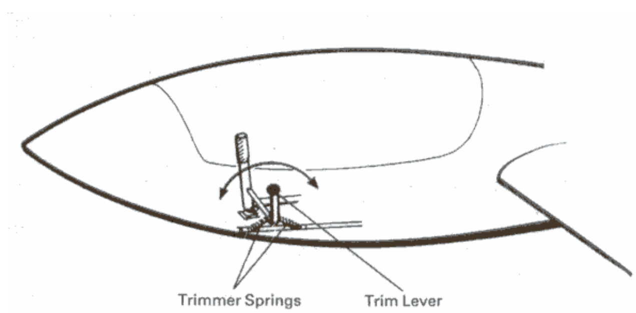
We have learnt and practiced control of the glider and are developing a good feel for the control inputs necessary to achieve the desired flight performance. You will have noticed that as we fly around, there is little load on the ailerons and rudder as they sit in their faired, neutral position, apart from when actually manoeuvering. On the other hand, the elevator has a load on it that changes for any desired change in speed / attitude and when turning… that backpressure required to hold the attitude. This loading can become tiring and relaxation of any load required leads to a change in attitude and an undesired speed excursion. To solve this problem, designers put a trim system on the elevator control that can be set by the pilot to relieve any load necessary to hold an attitude. The aim of all such systems is to therefore apply a force to the elevator that would otherwise be applied through the control column by the pilot.

Trim Systems:
There are a few different ways of achieving a simple trim system for the pilot to relieve any control loads. They include:

- **Tab trimmer** – here a small aerodynamic tab is attached to the elevator and linked back to a lever in the cockpit in such a way that when the pilot has to apply a load to the control column, they can move the trim lever in the same sense until the load is neutralized. Back at the tab, it actually moves in the opposite direction to the elevator movement required and provides an aerodynamic force to hold the elevator in the desired position. See the diagram below.



- **Spring trimmer** – instead of having an external tab, a spring system is attached to the elevator control and the trim control in the cockpit simply adjusts the tension on the spring in order to hold the control column in the desired position. This system has the advantage of not incurring the drag of the external tab system and does not require lengthy control runs down the fuselage to the elevator. The system is now common on modern gliders.



- **Anti-balance devices** – anti balance devices are sometimes added to gliders with very light control loads to add some *feel* to the control. An anti balance tab moves in the same direction as the control surface and increases the load required by the pilot to hold a desired attitude. If fitted with a trim tab it can be set to relieve the load required on the control column.

All trimming systems will have a neutral position that is usually marked in the cockpit so as to provide a datum for the pilot to reference any setting to. This is useful when presetting the trim for takeoff. The takeoff begins with no airflow over the elevator so the pilot has no real feel for where to set the trim. The manufacturer will recommend a setting and your Instructor will also advise of where to preset the trim for takeoff with your combined weights and the type of launch. Once the launch is underway and speed has stabilised, the pilot is free to retrim to offload any residual loading. Remember, for every attitude and speed, there will be a corresponding trim setting to relieve the load on the control column.

Air Exercise:

Your Instructor will take you around your glider, showing you what sort of trim system is installed and how it works. Sit in the cockpit and look at where the trim lever / actuator is located, what colour it is (usually green) and practise moving it / setting it. You want to be able to look, identify and operate it in flight with minimum delay when desired. Check where it is to be set for takeoff.

Once off tow, the Instructor will set the glider up in a steady glide at 45 knots, in trim. Relaxing their hold on the control column, they will point out that there is no loading on the control column as evidenced by the pitch attitude not changing and the speed remaining constant. They will now give you control and get you to select a lower nose attitude which requires holding a forward pressure on the control column. Feel how much loading is required and imagine how easy it is to relax and allow the attitude to change back towards the higher nose attitude or how tiring it would be to have to hold that load for some time. Now, moving the trim lever in the same direction as the load required will gradually reduce the load required till it is fully removed. The glider is now trimmed for the new attitude. Relaxing our grasp of the control column will allow you to check that the glider does not want to pitch away from the desired attitude.

Now your Instructor will ask you to select an attitude for a slower speed, say 40 knots, and once it is achieved, to retrim to hold it with no load on the control column. So, we first ease back to pitch the nose up to the attitude we think will see the glider settle at 40 knots. Then move the trim lever back to reduce the backpressure we are holding on the control column. Check if it is correct by relaxing your hold on the control column. If the glider wants to pitch away from the desired attitude, reselect the attitude, hold it and retrim.

Next select an attitude for a higher speed, say 60 knots, and go through the trimming sequence:
Select the attitude, let the speed settle at the new speed of 60 knots, make a small attitude correction if necessary, sense the load required to hold the attitude and move the trim to relieve the load being held. Relax to check the load has been trimmed out, make a small attitude adjustment if required and again retrim and check. Simple as that!!
Your instructor will get you to practise some more so you will gradually get used to retrimming each time you wish to fly at a different speed.

We will now explore the power of the trim to see what speed range can be trimmed for. The Instructor will get you to accelerate to a higher speed, say 100 knots, and retrim the glider. At some point, the glider will not be able to be trimmed for the speed desired so flight at any higher speed will require holding the load. Similarly, the Instructor will ask you to reduce speed to just above the stall and try to trim the load required to hold it. Depending on the glider and the cockpit weight, the glider may not be able to be trimmed for this speed; that is, even with the trim set at full aft, the glider still wants to pitch nose down and accelerate if the stick is let go.

Tips:
Your Instructor will periodically check that you are flying *in trim,* that is, you are not holding any residual load on the control column for the desired speed. They will either take control to check or ask you to relax your hold on the control column to see if the glider pitches away from the desired attitude. Aim to always fly *in trim.* If just doing a single turn, it may not be worth retrimming as any backpressure required in the turn will only be for a short time. However, if circling for some time, like in lift, retrimming is a good idea.
Form the habit…change the attitude… retrim. It will become second nature… but in doing so, avoid leading with the trim. Accurate trimming greatly reduces pilot fatigue and improves your flying accuracy and performance. It also allows you to concentrate on tasks like lookout, checking outside for what's happening, checking instruments, changing radio frequencies… any such tasks that take us away from the primary task of controlling the glider.

Need To Know:
- How to trim the glider for hands free flight at varying speeds.
- How to recognise and correct out of trim situations.

Further Reading:
- The Glider Pilot's Manual; by Ken Stewart. Page 73. Info on trimming.

USE OF AIRBRAKES

Aim: To learn how and when to use the airbrakes in a glider.

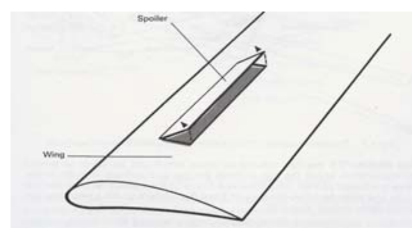
Gliders are extremely efficient machines that are designed to glide at a shallow angle over long distances. Manufacturers achieve this by using aerofoils (wings) that provide best lift for least drag so that for any given height, the glider glides the furthest possible distance… that is, it has the highest possible L/D ratio. Max L/D is great for soaring, but what about when it comes to descending for any reason or steepening our glide path as desired when coming in to land. We can steepen our glide by flying faster; this is converting our potential energy of height to kinetic energy of speed; diving our height off. However, we still have to slow down to land, so we need a way of increasing our drag to steepen our glide for a given speed. So, we want anything that increases drag, reduces our glide performance and reduces our L/D ratio. Manufacturers achieve this by designing pilot controlled drag devices. These include:

- Spoilers
- Airbrakes
- Trailing edge brakes
- Tail chutes

While some of these reduce lift, they all increase drag, thereby reducing the glider's energy and steepening it's glide. When considering the performance of the modern glider, say 40:1 at a speed of 50 knots, it is so flat that it would take a very long, flat approach to make a landing. This is hard to judge and requires obstacle free approach areas; a luxury not often available. Having made our approach to the landing area, we would be left trying to dissipate the energy of the glider decelerating from 50 knots. Any drag device therefore helps reduce the glide ratio, steepen the approach and dissipate the energy of the glider so we can approach over obstacles and land and stop in shorter distances. Another effect of the change in lift and drag is the stall characteristics will be altered. In general, all will cause the glider to stall at a slightly higher speed. This will be covered during the stalling exercises.

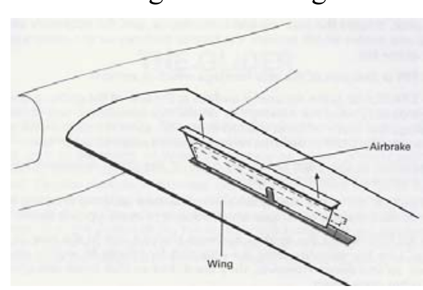
Spoilers:

Spoilers were used on early model gliders as they provided a simple means of spoiling the lift and increasing the drag by extending a hinged surface on the wing out into the airflow. They usually require holding open as the airflow tends to blow them closed. They become less efficient at higher speed compared to airbrakes and are not capable of limiting the speed of the glider in a dive.

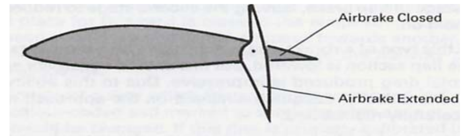


Airbrakes:

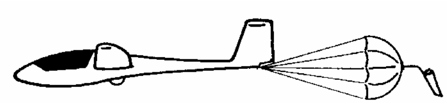
Airbrakes are large flat plates, sometimes perforated, that extend perpindicular to the wing's surface and create a large increase in drag as well as spoiling the lift generated by that area of the wing. Some designs have airbrakes extending above and below the wing. The position of the airbrakes determines their effectiveness and handling; ie. Does the glider pitch up or down when the brakes are extended. Airbrakes have a tendency to stay open or extend by themselves if allowed to so it is important that when using the airbrakes, the pilot maintains a firm grip on the brake lever to hold them at the desired position. Airbrakes have a positive lock to ensure they stay closed when not being used. Some airbrakes, called TV or Terminal Velocity Dive Brakes are powerful enough to provide sufficient drag to stop the glider exceeding its maximum speed in a vertical dive. Higher performance modern gliders are too efficient by comparison to the older designs so now manufacturers only achieve this speed limiting capability in up to 45° dives. Still, this is a very useful safety feature.



Trailing edge brakes:
This design is usually part of a combined trailing edge flap system which offers flap for improved performance and brake for steepening the glide for approach and landing. In its simplest form, the trailing edge is hinged to protrude both above and below the wing. On initial deployment / opening, the flap moving down may create additional lift but the airbrake portion above the wing will create sufficient drag to far outweigh the flaps effect. The drag increase can be quite dramatic which will cause a quicker deceleration when deployed so the nose attitude must be lowered to maintain the desired speed. This in turn offers steep approach angles. The design looks like this:



Tail chutes:
Any feature that interrupts the smooth laminar flow of air over the wing creates drag. To minimize this, some designers elected to do away with airbrakes and spoilers and turned to using tail chutes, deployed out of the rear of the fuselage, usually from a stowage compartment in the bottom of the rudder, to create a large amount of drag and thereby allowing for steepening of the approach. The tail chute can be deployed when needed and jettisoned when no longer needed. This feature is perhaps the tailchute's greatest weakness. Once out, their effectiveness varies with speed but if you get slow and need to shallow out the approach, you can only jettison the tailchute. You are then left with clean glide performance and the problems this creates. Having jettisoned the tail chute, you could be left with quite a search to recover it… or worse, if lost, the cost of a new one! Further considerations and training on their use will be covered later.



Air Exercise:
We start on the ground by taking a look at the airbrake system in our glider and discussing the likely handling and performance features of it. Your Instructor will then sit you in the glider and have you strap in before practicing the opening and closing of the brakes. Check out the load required to unlock and relock the brakes and check that full brake extension is available without any awkward contortions in the cockpit space available. Check whether the wheel brake is actuated in any way by the airbrake system. Can you see the brakes from the cockpit?
Once off tow, your Instructor will set the glider in a steady glide at 50 knots. Note the attitude, then follow through on the controls and the airbrake lever. They will open the airbrakes fully; watch for any pitch change; note any change in speed and check the rate of descent… you will probably feel the sink, but it can be seen as an increase in the rate of descent indicated on the vario and a more rapid loss of height on the altimeter. The brakes will then be closed; again note how the glider returns to the normal glide. You will then be given control and asked to try the same exercise but with the added requirement of maintaining the desired airspeed of 50 knots throughout. This will require you to lower the nose slightly as the brakes are deployed and raising it again as they are retracted. Also note the load required to extend and retract the brakes in flight. Consider retrimming to maintain a steady glide with the brakes extended, and retrimming when the brakes are retracted.
Now try extending and retracting the brakes at different speeds while maintaining the desired speed. Note the higher rates of descent and steeper glide angle and the higher physical loads as speed increases. When fully open, they can be quite hard to close. You need to be able to operate the brakes throughout the glider's speed range and control the rate of opening if extended at higher speeds. More on this later when we cover flight at higher speeds.

Tips:
Avoid levering brake against the control column, particularly when operating the brakes at higher speeds.

Need To Know:
- What type of airbrake system is fitted to your glider and how to look, identify and then operate the airbrakes.
- How to maintain our desired speed when changing our brake setting.

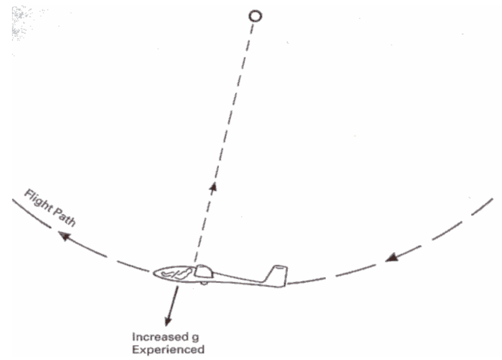
Further Reading:
- The Glider Pilot's Manual; by Ken Stewart. Page 78 – 83 and 189 – 191. Good all round info on airbrakes.

REDUCED G FAMIL

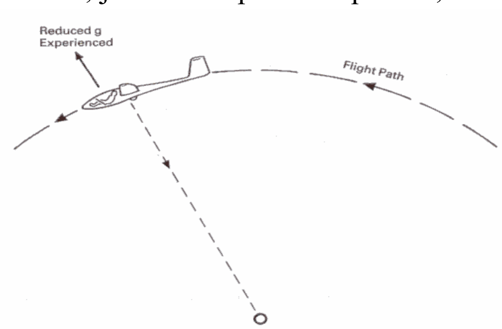
Aim: To familiarise you with the causes and sensations of flight at reduced G loading.

We have spent the majority of our life earthbound under the influence of the earth's gravity. This force on our body is measured in terms of what we weigh standing on the scales. The few times we have experienced being anything less than our normal weight is when we have been in an elevator moving up and down, in a car going over an undulating road or riding on some sort of carnival fair machinery. When doing any of these, we can feel our weight increase as we are forced towards our seat or feet as is the situation when the elevator moves off from ground level towards the top of the building. Conversely, we feel our weight reduce as we start from the top floor and descend to a lower level. In a car, this floating sensation is experienced when we speed over a sizeable hump in the road.

Positive G:
When flying, we have loads imposed on us whenever we manoeuvre or are subjected to turbulence. The loads that push us down into our seat and make us feel heavier are positive loads greater than the usual 1 G. These will have already been felt during turns and any pull-ups made in flight.



Reduced and Negative G:
Anything less than the 1G is considered reduced G and leaves us feeling lighter or floating. If we float neither up nor down, we are weightless or experiencing zero G. This is usually only experienced momentarily during some aerobatic manoeuvres so is not going to be dealt with here. However, just to complete the picture, if we were to roll upside down and fly along inverted, we would have to push forward on the control column and we would feel pushed against our straps and towards the canopy rather than into our seat. In this situation, we would be at –1G. This is quite an unfamiliar sensation for humans and can take a while to get used to having spent all our lives happily under a positive 1 G loading! For now though, we want to gradually introduce you to the sensation of reduced G so you can gain an understanding of what it feels like and how it occurs so we recognise it when we induce the sensation with our control inputs or have it imposed on us by the air we fly through.



Some people are more sensitive than others and some may even find the sensation unpleasant so we will aim to introduce you to the sensation gradually so as to stay within your comfort zone. For those that feel the sensation as one of falling, they may unwittingly extend arms and legs to involuntarily brace against the fall. Ever had one of those dreams where you are falling off a cliff or similar and you wake with a startle as your arms and legs involuntarily extend to the four corners of the bed? No… lucky… must be just me!
Anyway…its fine in bed but if flying along with one hand on the control column, the last thing you want to do is push forward if you sense you are falling as this will only make it worse!
So….just when might we expect to feel such a sensation in flight?

Reduced G can occur when:

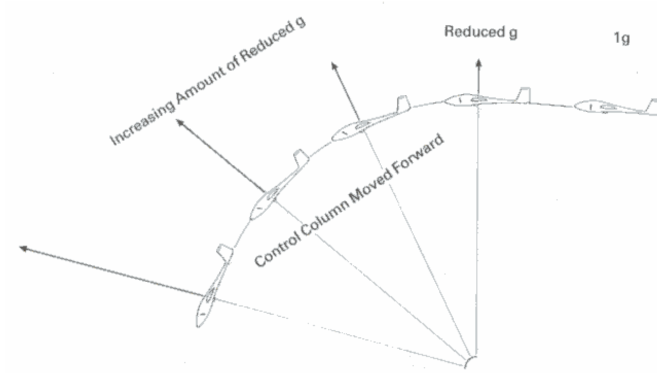
- We push forward on the control column to lower the nose form a high nose attitude as might be the case in a stall recovery
- We push the control column forward to lower the nose if the cable brakes on a wire launch
- We push forward suddenly on the control column for any other reason

Reduced G Compared to Sink When Stalled:

We will move on to exploring the handling and sensations of stalled flight shortly and one of the things you experience is the sinking sensation that can occur when the glider is stalled. The sink is infact a useful symptom of the stall, but not the only symptom and it can easily be mistaken for that induced by the pilot whenever they push forward on the control column.

Here-in lies the trap.

Sink is a symptom of the stall; **reduced G is not.**



We need to give you experience and confidence in discriminating between the pilot induced reduced G situation and that sinking feeling that may occur when a glider is stalled or during the pilots recovery as they push forward on the control column. If the reduced G sensation is sustained or increasing, it is essential that you realize that the glider is not stalled and that the sensation will cease if you stop pushing on the control column and pull back so as to pitch up towards the normal gliding attitude.

Air Exercise:

You need to be around 2000 ft agl for this exercise. Complete the pre manoeuvre (HASELL) checks then your Instructor will get you to follow through as they make gentle dives and pull-ups so you feel the increased G, then push-overs so you feel the reduced G. Practise some yourself to gain confidence with the new sensation, noting the reduced G comes in as you push forward on the control column.

Next, your Instructor will have you follow through as they dive, then pull up to about 30° above the horizon. Holding the nose up, the speed will reduce and the glider will stall, pitch forward by itself and then recover with a small input from the instructor. Note there is little sensation of reduced G.

Following through, now repeat the dive and pitch up but before the speed reduces to near the stall, the Instructor will push the control column forward to lower the nose. Note this time the reduced G as a consequence of our control input. The glider is not stalled and remains fully controllable throughout.

You will be given control and asked to establish a steady glide at 45 knots. When told, move the control column forward sharply by a small amount to induce the reduced G sensation, then return to the steady glide.

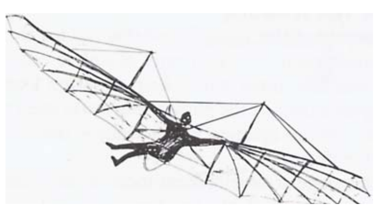
Your Instructor will gradually expose you to more situations of reduced G so you gain confidence with the sensation and build up experience so there is no confusion between the sinking feeling that can occur during a stall and the sensation induced by us as pilots when we push forward on the control column. They will also be checking to ensure you are not one of a very small percentage of the population who remain hypersensitive to the sensation and continue to suffer discomfort and possible disorientation during reduced G manoeuvres.

Tips:

Experienced pilots can easily forget how they were sensitive to these unfamiliar situations and manoeuvres as they now cope with them without thinking. You however are still getting used to it so if you feel discomfort or worse, feel crook, speak up early rather than wait till you get lumps in your language!

Need To Know:

- How the sensation of reduced G occurs.
- How to discriminate between reduced G and sink.
- Not to worry about falling off cliffs or out of high-rise windows in your dreams!



Otto Lilienthal used this when jumping off cliffsback in the late 1800's

Further Reading:

- The Glider Pilot's Manual; by Ken Stewart. Pg 61. Reduced G famil
- Human Factors For Pilots; by Dr Ross Ewing. Good all round info on G tolerance and Human Factors.